Control of Computer Room Air Conditioning using IT equipment sensors

Demonstration at the Intel Corporation SC-11 Data Center
January 2009 – July 2009

Opening Remarks:
Thanks to our supporters!

Data Center Owners and Operators:
How would you like to…

➢ **Reduce costs**
>   **by saving energy…**

AND

➢ **Increase reliability**
>   **by better managing your assets…**

Interested?

Data Center Owners and Operators: An answer…

Control your data center air conditioning by using the built-in IT server-equipment temperature sensors

Background:

❖ Typically, data center cooling devices use return air temperature sensors as the primary control-variable to adjust supply air temperature to the data center.

➢ **Promotes** energy inefficiency; a single-point, "open loop" control method without feedback.

➢ **Blends** server return air temperature; does not provide any specific information about a server's temperature or health.

Evolution:

❖ ASHRAE Guidelines:
Server manufacturers have agreed; main operational parameter is server inlet air temperature.

❖ Intelligent Platform Management Interface (IPMI):
Server inlet air temperature is monitored and available from ICT manageability network, either IPMI or SNMP (simple network management protocol).

Demonstration Project: Primary Goals…

✓**Prove** operating information uploaded and downloaded from/to server's ICT manageability network to/from building management system.

✓**Establish** FMS provides, and receives verification of, set point changes to data center conditioning systems in response to temperature information from servers.

LBNL mission:

✓**Perform** independent "white-paper" review of project.

✓**Provide** knowledgeable support to <u>all</u> parties involved.

✓**Share** project findings with data center community.

✓**Satisfy** PIER and CEC resource needs…

Demonstration Project: Results…

❖ **Demonstrated** and **Validated** successfully that computer servers can:
- ✓ provide temperature information to a facility management system
- ✓ subsequently have the FMS determine and provide operating setpoint(s) for cooling system operations.

❖ **Completed** effective two-way communications and closed-loop control without significant interruption or reconfiguration of the ICT or FMS devices.
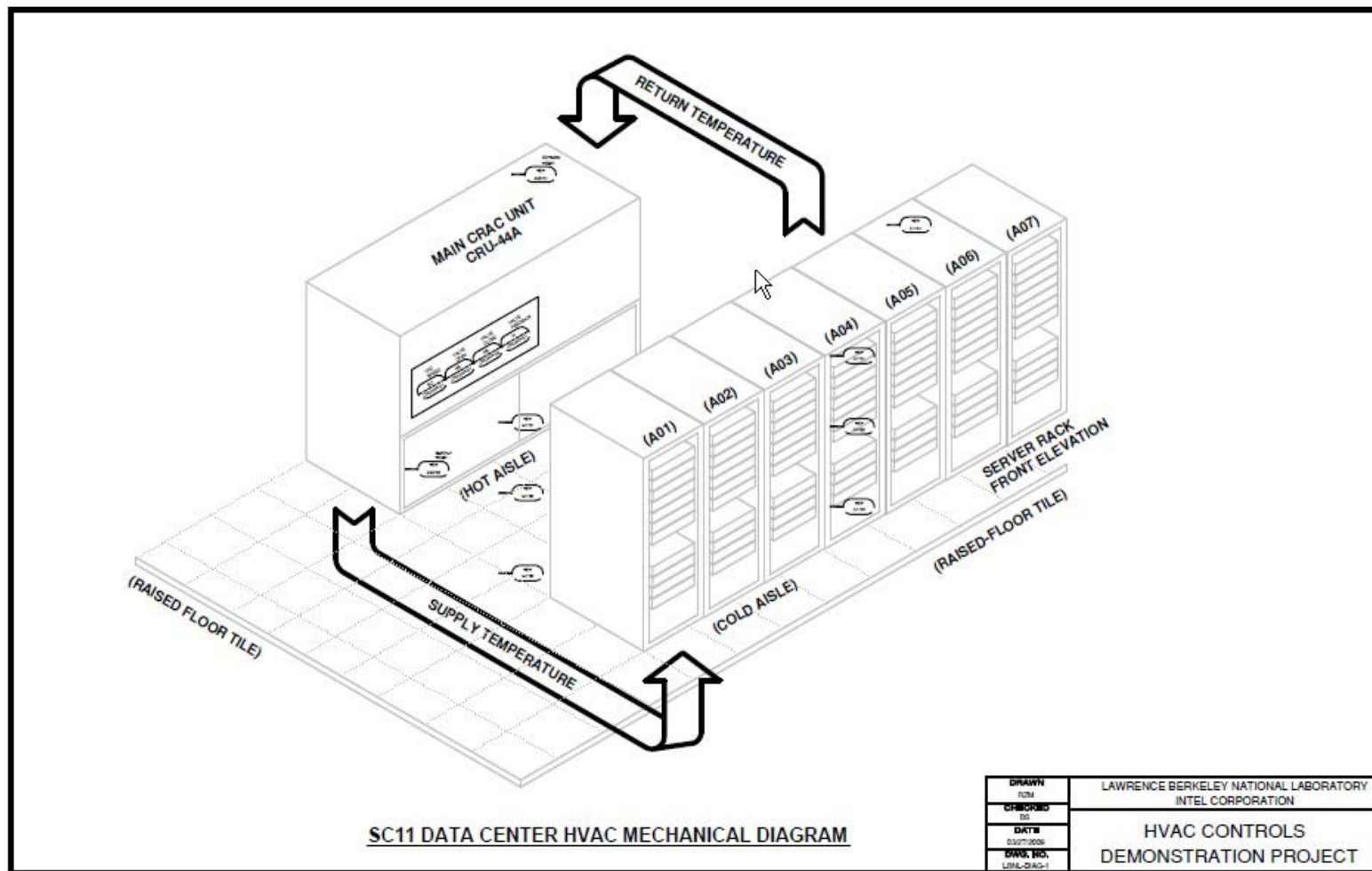
BERKELEY LAB

(intel)

Intel Data Center: Layout…

Description:

- **xxxx Sq Ft**
- **2 CRAH cooling units**
- **xxx kW load**

Intel Data Center HVAC:

SC11 DATA CENTER HVAC MECHANICAL DIAGRAM
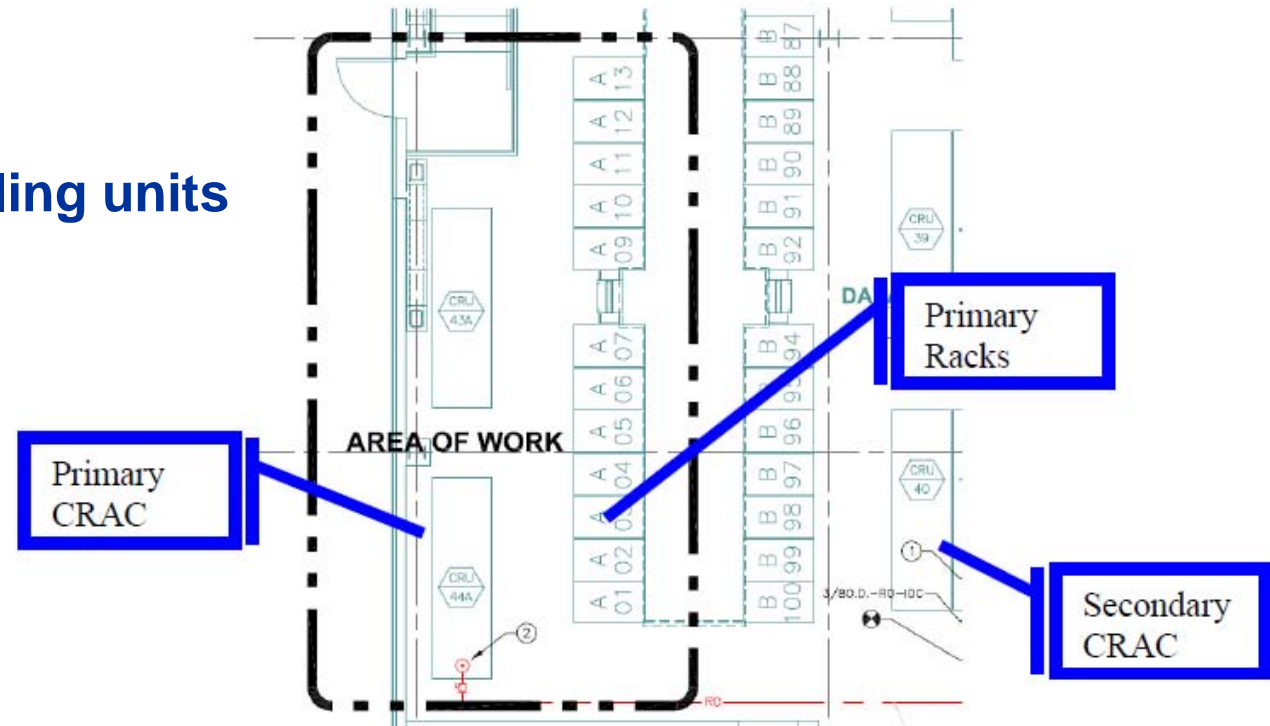
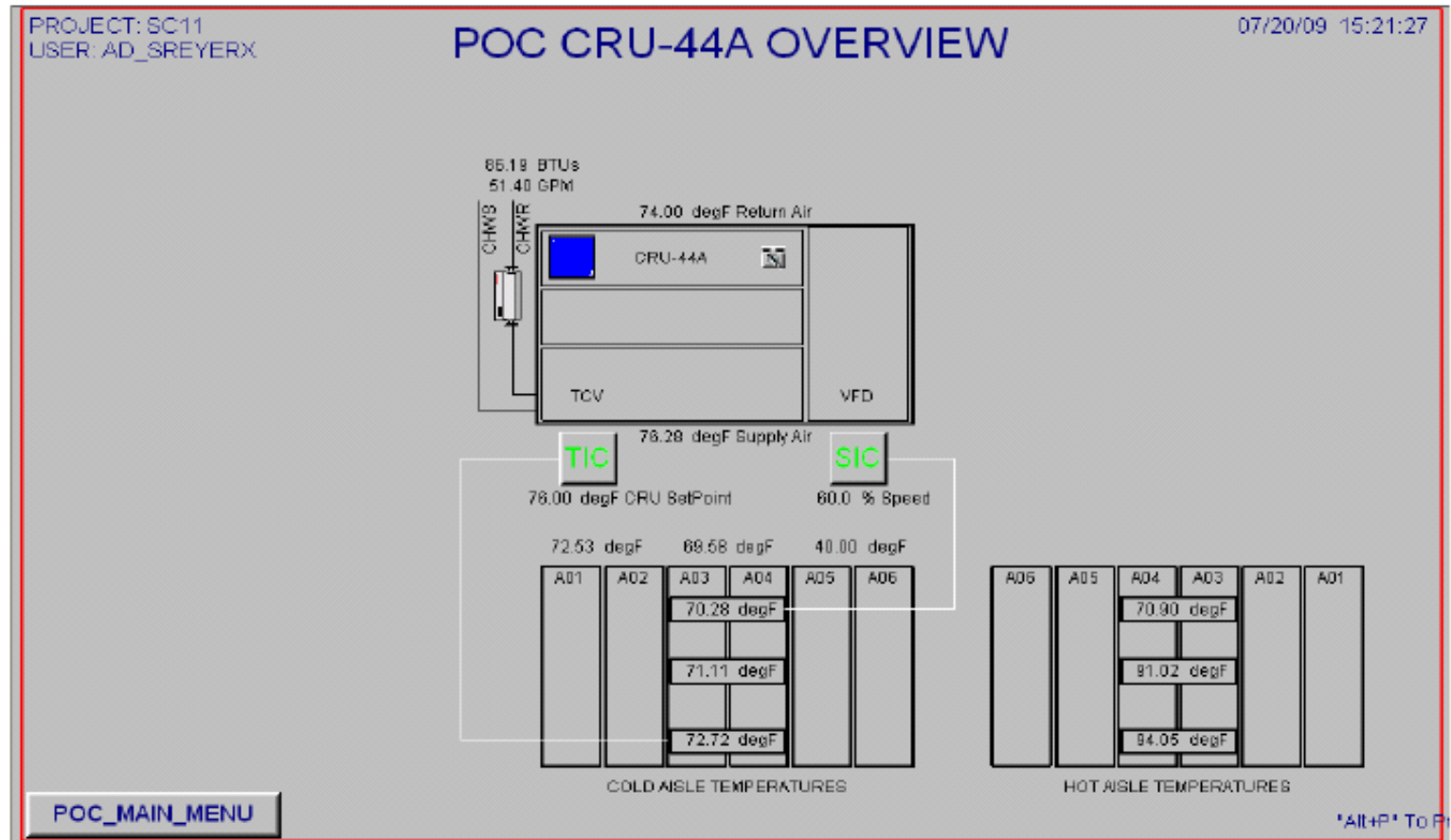# Intel Data Center Communication:
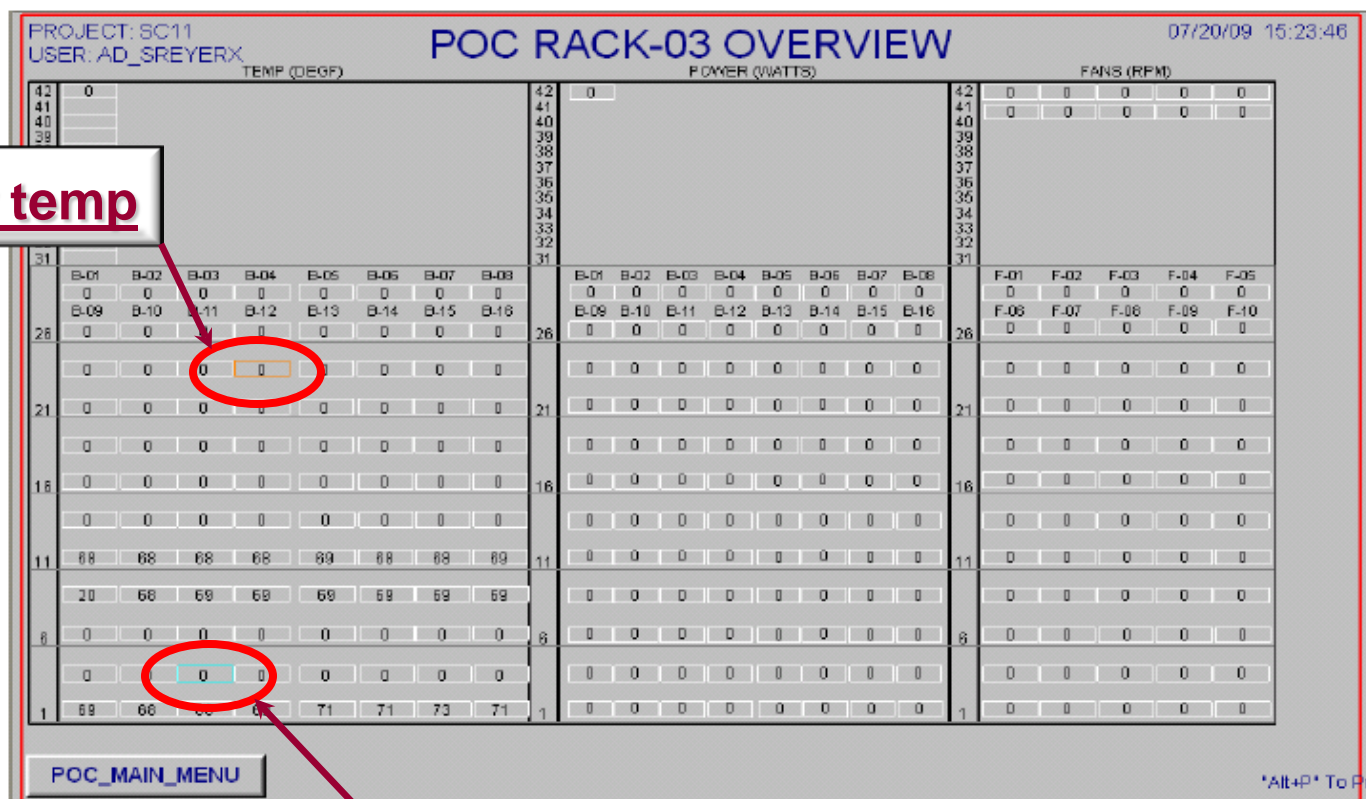

SC11 DATA CENTER COMMUNICATION DIAGRAM
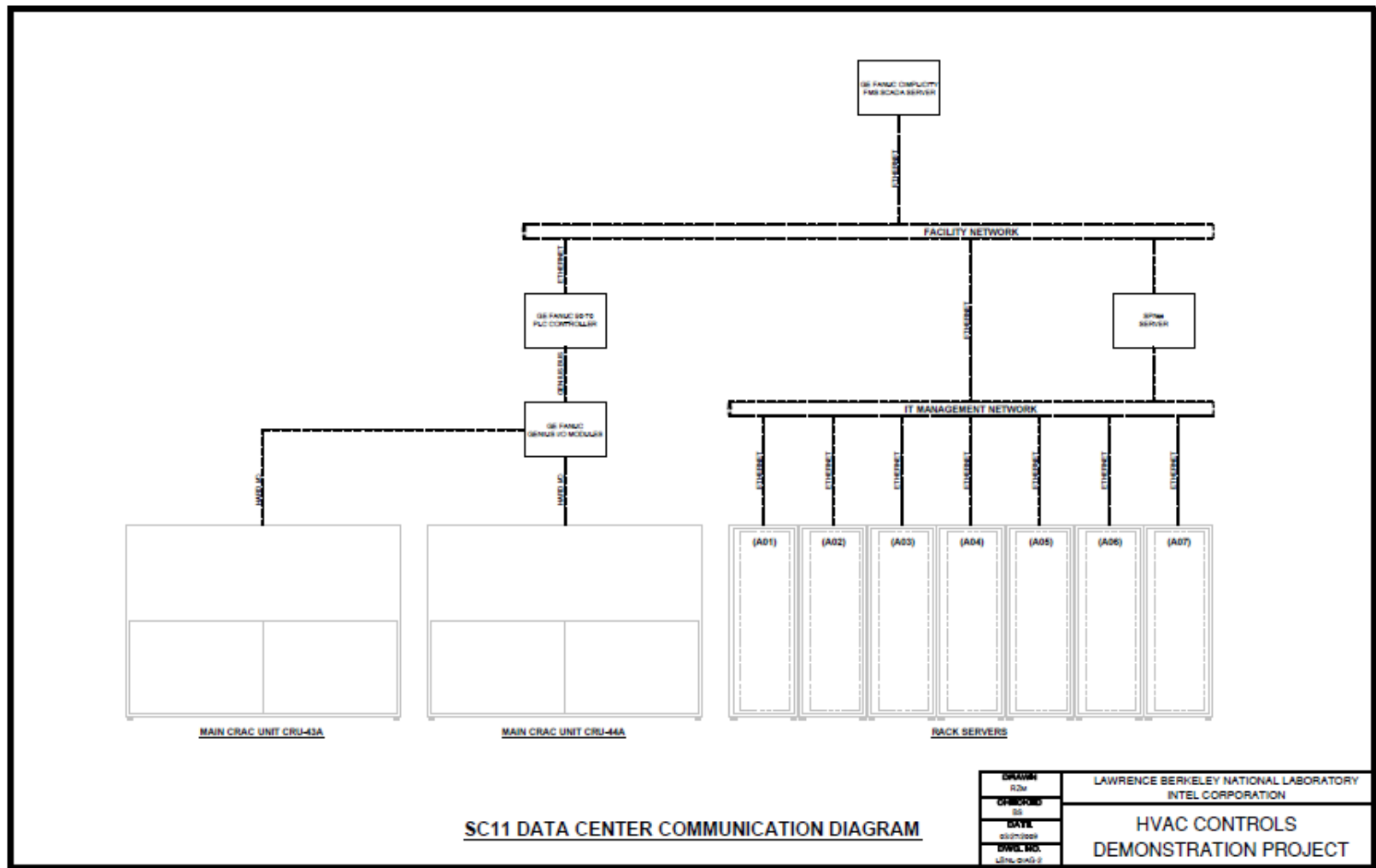
Cimplicity FMS HMI:
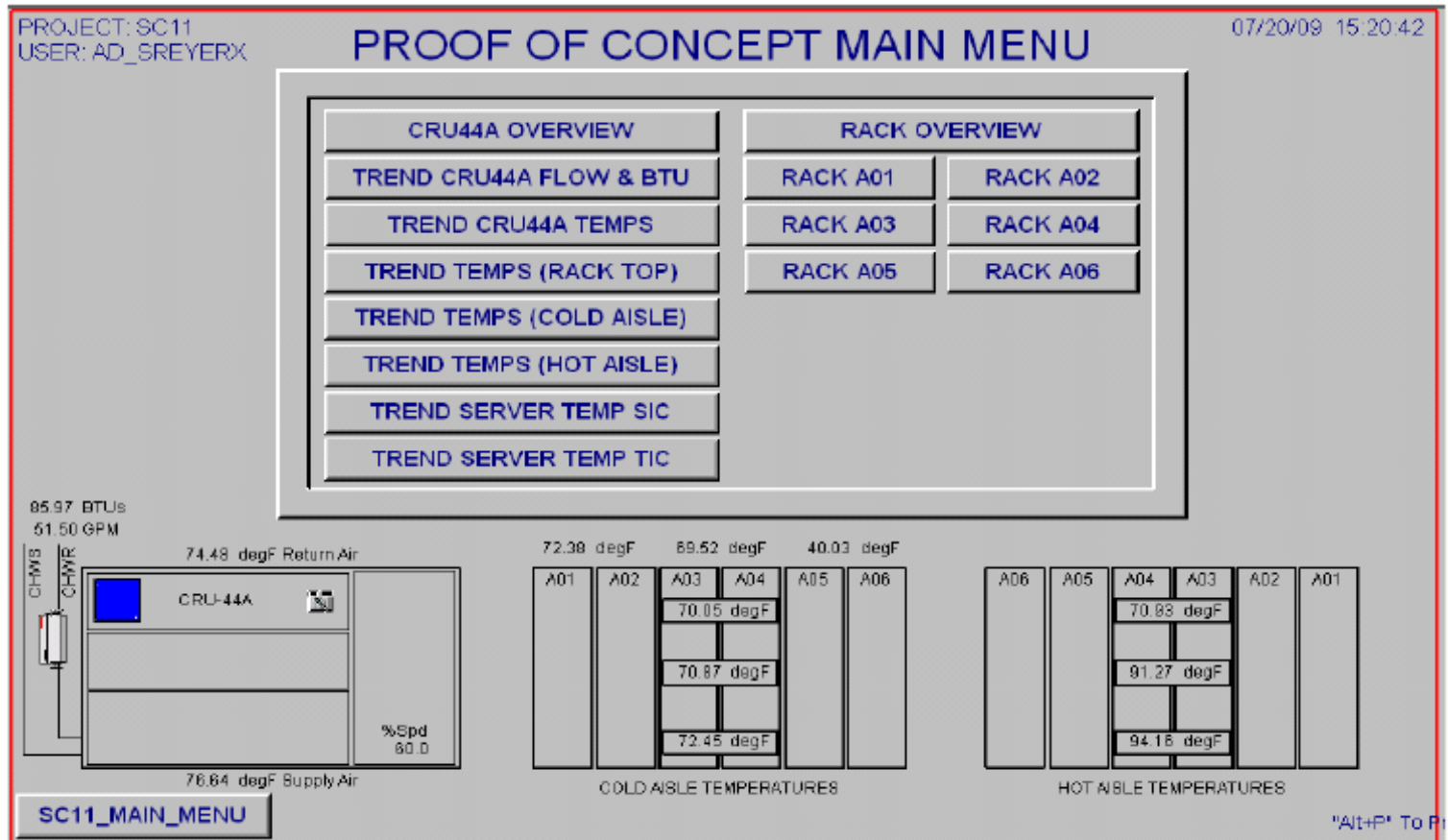
CRAH & Sever Communication:

Selected servers for control input:

Higher server temp

Lower server temp

FMS takes control…

Server Temperature Control by Cooling Device

Legend:
- PID Control - Input
- Server - Result
- Chilled Water - Response

Notes:
1. Test Begins- PID sends initial setpoint to CV; CV begins to open
2. CRAH unit limits CV operation.
3. PID gets server temp. data that setpoint is reached; server temp. continues lower; Result: PID sends higher setpoint to CV.
4. Server sends temp data to PID that setpoint achieved; PID sends same setpoint until [5].
5. Severver temp. increases due to compute load; PID responds by sending lower setpoint to CV; CV opens.
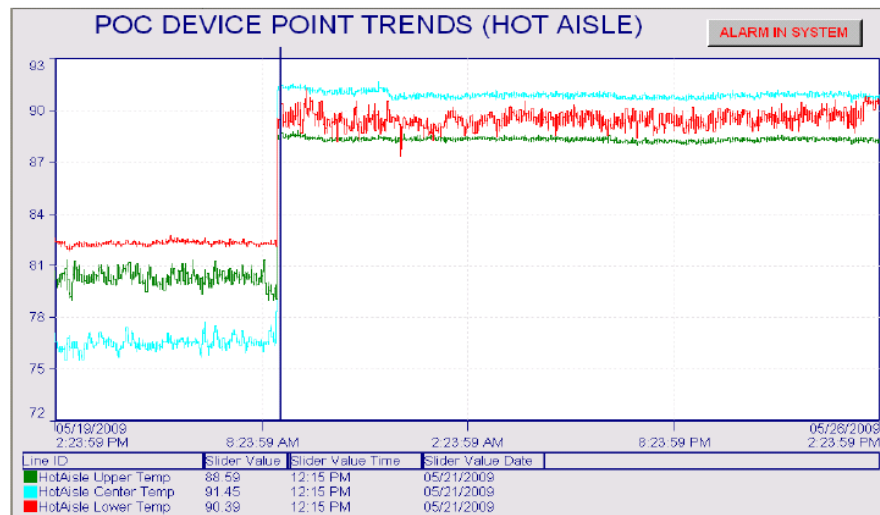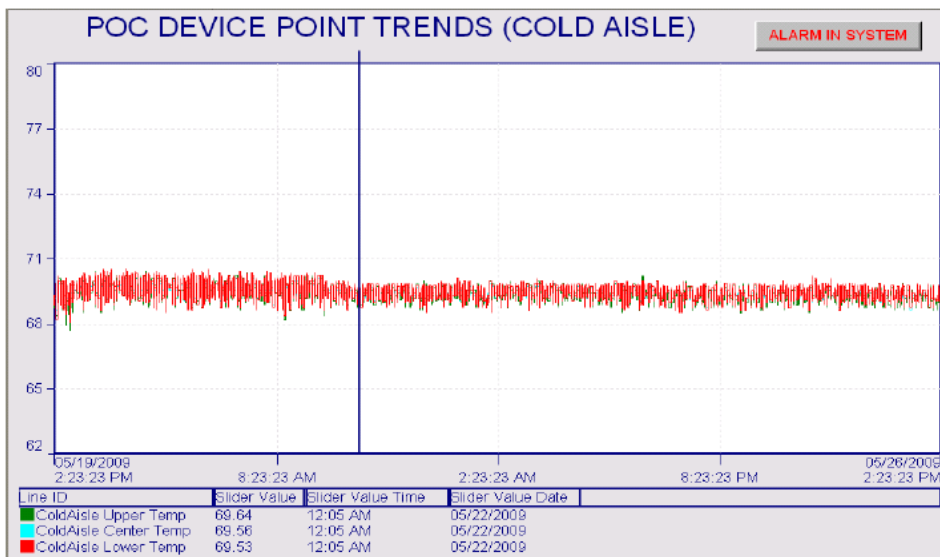6. Server sends temp data that setpoint is achieved; PID sends same setpoint until [7].
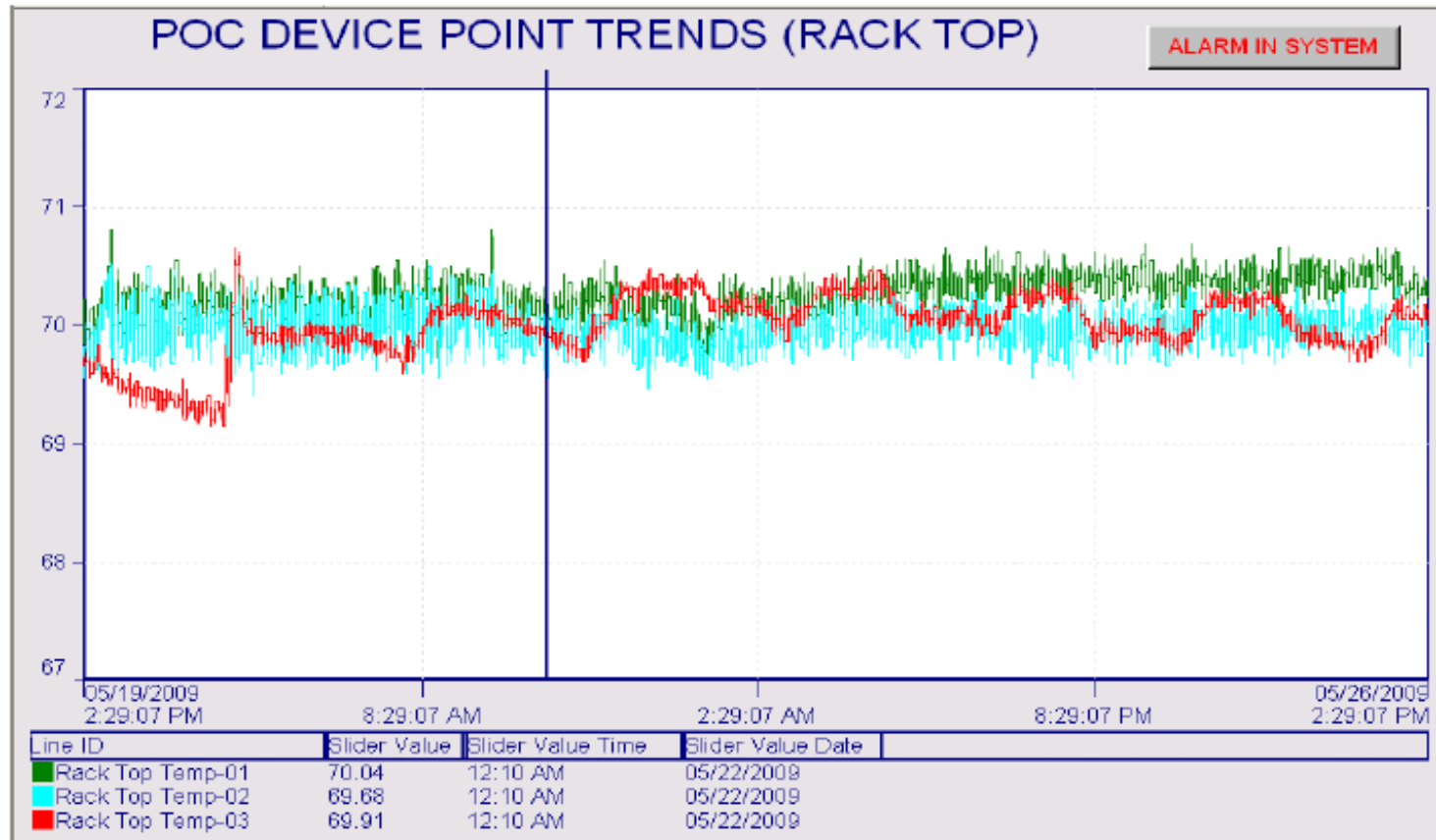7. Test Ends.

Server Inlet & Leaving Air Temps:

Top of Rack Temps: Too much airflow?

Lessons learned:

❖ **Control logic scheme within the CRAH unit could not be completely bypassed:**

- ▪ **continually interrupted external CW-valve PID control.**

- ▪ **limited fan speed to no lower than 60 percent of full speed.**

❖ **Floor tile arrangement very important.**

❖ **Missing server blanking plates can negate efficiency gains.**

Closing Remarks: Suggested next steps…

➢ **Scrutinize** floor tile arrangement.

➢ **Use** fan speed to balance supply airflow:

  ✓ Eliminate excess airflow over the top of the racks

  ✓ Prevent recirculation from hot-aisle to cold-aisle.

➢ **Coordinate** CW valve and VFD fan-speed controls.

➢ **Identify** interface communication devices to facilitate connection between IPMI and ASHRAE's BACnet protocols.

Real improvements; No waiting; Let's *do it!*

- ✓ **Readily available…**

- ✓ **Applicable throughout the U.S. …**

- ✓ **Short payback period...**

- ✓ **Creates jobs…**

- ✓ **Saves energy and the environment…**

Questions?

For More Information

http://hightech.lbl.gov/datacenters.html

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